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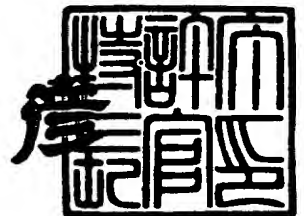
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【プルーフの要否】 要

【書類名】 明細書

【発明の名称】 二次電池

【特許請求の範囲】

【請求項 1】 正極集電体に正極材料を付着させた正極板と負極集電体に負極材料を付着させた負極板とをセパレータを介して積層した極板群を電解液とともに電池容器内に収容した二次電池において、極板群の少なくとも一側部において何れかの極板の集電体を突出させ、その突出部の先端に自身によって形成した平坦部に集電板を接合したことを特徴とする二次電池。

【請求項 2】 正極板と負極板をセパレータを介して渦巻き状に巻回し、その両端に両極板の集電体をそれぞれ突出させた極板群を設け、極板群の端部を巻回軸芯方向に押圧して平坦部を形成したことを特徴とする請求項 1 記載の二次電池。

【請求項 3】 平坦部に集電板を当接配置し、周方向複数箇所を放射方向にレーザ溶接したことを特徴とする請求項 2 記載の二次電池。

【請求項 4】 集電板に、集電体の突出部に向けて突出する突条部を突設し、突条部を押圧させることにより集電体の平坦部を形成すると共に、突条部で集電体と集電板を溶接したことを特徴とする請求項 2～3 の何れかに記載の二次電池。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】

本発明は二次電池に関し、特に正極集電体に正極材料を付着させた正極板と負極集電体に負極材料を付着させた負極板とをセパレータを介して積層した極板群を電解液とともに電池容器内に収容した二次電池に関するものである。

【0002】

【従来技術】

近年、電子機器の小型化、軽量化が急速に進んでおり、その電源としての電池に対しても小型・軽量化と高容量化の要望が高まっている。

【0003】

その要望に対して、負極活物質として炭素系材料を用い、正極活物質に LiCoO_2 などのリチウム含有遷移金属酸化物を用いたリチウムイオン二次電池が各社で実用化されている。このリチウムイオン二次電池は、負極活物質として金属リチウムあるいはリチウム合金を用いたリチウム二次電池のように充電により負極上へのリチウムの析出が発生しないため、良好なサイクル特性が得られている。そのため、現在電子機器への搭載が進むなど、リチウムイオン二次電池の開発が盛んに行われている。

【0004】

また、地球環境問題、あるいはエネルギー問題を解決する手段としても、リチウムイオン二次電池の開発が盛んに行われている。地球環境を良好に保全しつつ電力の安定確保を図っていく方策の一つとして負荷の平準化技術の実用化が望まれているが、一般家庭などで小規模に夜間電力を貯蔵する電池電力貯蔵装置を普及させると、大きな負荷平準化効果が期待できる。また、自動車の排気ガスによる大気汚染や CO_2 による温暖化防止を図るために、動力源の全部又は一部を二次電池によって得るようにした電気自動車の普及も望まれている。このため、家庭用の電池電力貯蔵装置や電気自動車の動力源として、単電池容量が 100Ah 程度の大型のリチウムイオン二次電池の開発も行われている。

【0005】

この種のリチウムイオン二次電池の構造は、図5に示すように、正極集電体 21b に正極材料 21a を付着させた正極板 21 と、負極集電体 22b に負極材料 22a を付着させた負極板 22 とをセパレータ 23 を介して渦巻き状に積層した極板群 30 を電解液とともに電池缶 25 と電池蓋 26 とから成る電池容器 24 内に収容し、正極集電体 21b の適所に一端を接合した正極集電タブ 28 の他端を正極端子となる電池蓋 26 の内面に接続し、負極集電体 22b の適所に一端を接合した負極集電タブ 29 の他端を負極端子となる電池缶 25 の内底面に接続して構成されている。

【0006】

【発明が解決しようとする課題】

ところが、上記構成の二次電池では、正極板 21 及び負極板 22 の 1 箇所から

集電タブ 28、29 を介して電流を取り出すようにしているので、正極板 21 や負極板 22 から集電タブ 28、29 までの平均距離が長くまた集電タブ 28、29 の面積も小さいために電気抵抗が大きく、集電効率が悪いために大電流で充放電を行うと温度が上昇して寿命が短くなるという問題があった。

【0007】

なお、このような問題を解消する手段として、例えば特開平 8-115744 号公報には、両極板の集電体をそれぞれ反対側の側部に突出させてその突出部の先端部にそれぞれリード線を配置した状態でセパレータを介して両極板を巻回することにより、両端にリード線と集電体の端縁にて形成された正極端面と負極端面を有する極板群を構成し、これら正極端面と負極端面にそれぞれの端子を接続したものが開示されている。しかし、リード線が必要となるとともに製造工程も複雑になるため、コスト高になるという問題がある。

【0008】

また、特開平 10-21953 号公報には、両極板の集電体をそれぞれ反対側の側部に突出させ、それらの先端部を正極端子及び負極端子に弾性的に圧接させるようにしたものが開示されている。しかし、集電体の先端部を弾性範囲内で鋭角状に曲げ、その弾性復元力で端子に接続しているだけであるため、電氣的な接続が不安定で、振動を受けるような使用状態では電池出力の安定性に欠けるという問題がある。

【0009】

本発明は、上記従来の問題点に鑑み、集電効率が高く、充放電時の温度上昇を小さくでき、かつ安価な構成で安定的に充放電できる二次電池を提供することを目的としている。

【0010】

【課題を解決するための手段】

本発明の二次電池は、正極集電体に正極材料を付着させた正極板と負極集電体に負極材料を付着させた負極板とをセパレータを介して積層した極板群を電解液とともに電池容器内に収容した二次電池において、極板群の少なくとも一側部において何れかの極板の集電体を突出させ、その突出部の先端に自身によって形成

した平坦部に集電板を接合したものであり、集電体の一側部にて形成された平坦部に集電板が接合されるので集電効率が高く、充放電時の温度上昇を小さくでき、かつ集電体自身で平坦部を形成しているので安価に構成できるとともにその平坦部に集電板を接合しているので振動等に対しても安定した構造となり、安定的に充放電できる。

【0011】

また、正極板と負極板をセパレータを介して渦巻き状に巻回し、その両端に両極板の集電体をそれぞれ突出させた極板群を設け、極板群の端部を巻回軸芯方向に押圧して平坦部を形成すると、集電板を接合するための集電体の平坦部を押圧によって能率良く形成することができる。

【0012】

また、平坦部に集電板を当接配置し、周方向複数箇所を放射方向にレーザ溶接すると、集電体の側端縁の多数箇所を集電板に簡単に一体溶着することができ、高い集電効率を作業性良く達成することができる。

【0013】

また、集電板に、集電体の突出部に向けて突出する突条部を突設し、突条部を押圧させることにより集電体の平坦部を形成すると共に、突条部で集電体と集電板を溶接すると、集電板と平坦部が突条部で確実に接し、集電板と集電体のより確実な接合状態が得られる。

【0014】

【発明の実施の形態】

以下、本発明の二次電池の一実施形態のリチウムイオン二次電池について、図1～図3を参照して説明する。

【0015】

図1において、1は正極板、2は負極板で、微多孔ポリエチレンフィルムから成るセパレータ3を介して互いに対向された状態で渦巻き状に巻回されて極板群10が構成され、この極板群10が電解液とともに電池容器4内に収納配置されている。電池容器4は負極端子となる円筒容器状の電池缶5と正極端子となる電池蓋6にて構成され、電池缶5の上端開口部内周と電池蓋6の外周との間に介装

された絶縁パッキン 7 にて相互に絶縁されるとともに電池容器 4 が密閉されている。なお、極板群 10 と電池缶 5 の内周との間にもセパレータ 3 は介装されている。

【0016】

正極板 1 は、正極集電体 1 b の両面に正極材料 1 a を塗工して構成されるとともに、その正極集電体 1 b の一側部（図示例では上側部）が正極材料 1 a の塗工部より突出されている。また、負極板 2 は、負極集電体 2 b の両面に負極材料 2 a を塗工して構成されるとともに、その負極集電体 2 b の他側部（図示例では下側部）が負極材料 2 a の塗工部より突出されている。セパレータ 3 は正極板 1 及び負極板 2 の塗工部の両側縁よりも外側に突出されている。

【0017】

そして、正極集電体 1 b のセパレータ 3 より突出した部分を押圧することによって正極集電体 1 b の突出部を塑性変形させて平坦部 11 が形成され、この平坦部 11 に正極集電板 8 が接合されている。同様に、負極集電体 2 b のセパレータ 3 より突出した部分を押圧することによって負極集電体 2 b の突出部を塑性変形させて平坦部 12 が形成され、この平坦部 12 に負極集電板 9 が接合されている。これら正極集電板 8 及び負極集電板 9 はそれぞれ電池蓋 6 と電池缶 5 に接続されている。8 a、9 a は、集電板 8、9 を電池蓋 6 の内面及び電池缶 5 の内底面に接合するためその外周から延出された接続片である。

【0018】

正極板 1、負極板 2、及び電解液について詳細に説明すると、正極集電体 1 b はアルミ箔などから成り、その両面に正極活物質と結着剤を含む正極材料 1 a を塗工して正極板 1 が構成されており、その正極活物質としては、 LiCoO_2 、 LiMn_2O_4 、 LiNiO_2 、若しくはこれら Co、Mn、Ni の一部を他の遷移金属で置換したもの、あるいはそれ以外のリチウム含有遷移金属酸化物が用いられる。特に、地球上に豊富に存在し、低価格である LiMn_2O_4 などの Mn 系リチウム含有遷移金属酸化物が適している。

【0019】

負極集電体 2 b は銅箔などから成り、その両面に負極活物質と結着剤を含む負

極材料2aを塗工して負極板2が構成されており、その負極活物質としては、グラファイト、石油コークス類、炭素繊維、有機高分子焼成物などの炭素質材料を用いるか、リチウムを吸蔵、放出可能な金属、あるいは酸化物、若しくはこれらの複合化材料が用いられる。

【0020】

また、電解液は、溶質として6フッ化リン酸リチウム (LiPF_6)、過塩素酸リチウム (LiClO_4)、ホウフッ化リチウム (LiBF_4) などのリチウム塩、溶媒としてエチレンカーボネイト (EC)、プロピレンカーボネイト (PC)、ジエチレンカーボネイト (DEC)、エチレンメチルカーボネイト (EMC) などの非水溶媒単独、若しくはそれらの混合溶媒を用い、この溶媒に溶質を $0.5 \text{ mol/dm}^3 \sim 2 \text{ mol/dm}^3$ の濃度に溶解したものが使用される。

【0021】

具体例を示すと、正極板1は、電解二酸化マンガン (EMD: MnO_2) と炭酸リチウム (Li_2CO_3) とを $\text{Li/Mn}=1/2$ となるように混合し、 800°C で20時間大気中で焼成して製造した正極活物質の LiMn_2O_4 と、導電剤のアセチレンブラックと、結着剤のポリフッ化ビニリデンとを、それぞれ重量比で92:3:5の割合で混合したものを正極材料1aとした。なお、正極材料1aをペースト状に混練するために結着剤としてのポリフッ化ビニリデンはNメチルピロリドンディスパージョン液を用いた。上記混合比率は固形分としての割合である。この正極材料ペーストを、厚み $20 \mu\text{m}$ のアルミ箔から成る正極集電体1bの両面に一侧縁部に幅 10 mm の非塗工部を残した状態で塗工し、正極材料層を形成した。正極材料層の両膜厚は同じで、塗工、乾燥後の両膜厚の和は $280 \mu\text{m}$ で、正極板1の厚さを $300 \mu\text{m}$ とした。その後、正極板1の厚みが $200 \mu\text{m}$ になるように直径 300 mm のプレスロールにより圧縮成形した。このとき、正極材料密度は 3.0 g/cm^3 であった。

【0022】

負極板2は、人造黒鉛と結着剤のスチレンブタジエンゴム (SBR) とを重量比97:3の割合で混合したものを負極材料2aとした。なお、負極材料2aをペースト状に混練するために結着剤としてのスチレンブタジエンゴムは水溶性の

デイスパージョン液を用いた。上記混合比率は固形分としての割合である。この負極合剤ペーストを厚み $14\ \mu\text{m}$ の銅箔から成る負極集電体 2b の両面に一側縁部に幅 10mm の非塗工部を残した状態で塗工し、負極材料層を形成した。その後、負極板 2 の厚みが $170\ \mu\text{m}$ になるように直径 300mm のプレスロールにより圧縮成形した。このとき、負極材料密度は $1.4\text{g}/\text{cm}^3$ であった。

【0023】

電解液は、エチレンカーボネイト (EC) とジエチレンカーボネイト (DEC) を体積比 1 : 1 の配合比で混合した混合溶媒に、溶質として 6 フッ化リン酸リチウム (LiPF_6) を $1\text{mol}/\text{dm}^3$ の濃度に溶解したものをを用いた。

【0024】

このリチウムイオン二次電池の製造に当たっては、上記のようにして作製した正極板 1 と負極板 2 をセパレータ 3 を介して対向させかつそれらの集電体 1b、2b の突出部を両端に突出させた状態で渦巻き状に巻回して極板群 10 を形成し、この極板群 10 を、図 2 に示すように、円筒容器状の成形治具 13 内に挿入配置し、成形治具 13 の一端開口から押圧具 14 にて押圧する。すると、集電体 1b、2b の突出部が仮想線で示すように径方向内側に向けて略 90° 折り曲がるように塑性変形され、平坦部 11、12 が形成される。即ち、正極板 1 及び負極板 2 が渦巻き状に巻回されているので、集電体 1b、2b の突出部が径方向外側には屈折せず、全体が略均等に逐次径方向内側に向けて折り曲げるように塑性変形されることになり、多少の皺を生じさせながらも全体として平坦部 11、12 が形成されることになる。

【0025】

次いで、平坦部 11、12 を形成した極板群 10 を成形治具 13 から取り出し、図 3 に示すように、集電板 8、9 を平坦部 11、12 に押し付けるように配置して両者を圧接させた状態で、集電板 8、9 の表面の周方向複数箇所を中心部から外周縁まで放射状にレーザビーム 15 を照射することによって集電板 8、9 と平坦部 11、12 をレーザ溶接する。その後、この集電板 8、9 を接合した極板群 10 を電池缶 5 内に電解液とともに収容して真空含浸させ、電池蓋 6 で密閉するとともに、集電板 8、9 と電池蓋 6 と電池缶 5 をそれぞれレーザ溶接等にて接

続する。

【0026】

以上の構成のリチウムイオン二次電池によれば、正極板1と負極板2をセパレータ3を介して渦巻き状に巻回し、その両端に両極板の集電体1b、2bをそれぞれ突出させた極板群10を設け、極板群10の両端から突出している各集電体1b、2bにて形成された平坦部11、12に集電板8、9が接合されているので集電効率が高く、充放電時の温度上昇を小さくできる。しかも、平坦部11、12は、集電体1b、2b自身で形成しているので安価に構成できるとともにその平坦部11、12に集電板8、9を接合しているので振動等に対しても安定した構造となり、安定的に充放電できる。

【0027】

また、極板群10の両端部を巻回軸芯方向に押圧して平坦部11、12を形成しているので、集電板8、9を接合するための集電体1b、2bの平坦部11、12を押圧によって能率良く形成することができる。

【0028】

また、平坦部11、12に向けて集電板8、9を押圧し、圧接させた状態で周方向複数箇所を放射方向にレーザー溶接しているので、集電体1b、2bの側端縁の多数箇所を集電板8、9に簡単に一体溶着することができ、高い集電効率を作業性良く達成することができる。

【0029】

上記実施形態の説明では、集電板8、9として全面が平板状のものを例示したが、図4に示すように、集電板8、9に、極板群10の集電体1b、2bの突出部に向けて突出する突条部16を放射状に突出形成し、その突条部16を突出部に食い込むように集電板8、9を押圧し、突出部に平坦部11、12を形成した状態で突条部16に沿ってレーザー溶接するようにしてもよい。

【0030】

このように集電板8、9に突条部16を突設し、これを集電体1b、2bの突出部に押圧してレーザー溶接すると、集電板8、9と突出部に形成された平坦部11、12が突条部16を介して確実に接し、集電板8、9と集電体1b、2bの

より確実な接合状態が得られる。

【0031】

【発明の効果】

本発明の二次電池によれば、以上の説明から明らかなように、極板群の少なくとも一側部において何れかの極板の集電体を突出させ、その突出部の先端に自身によって平坦部を形成し、集電板を接合したので、集電効率が高く、充放電時の温度上昇を小さくでき、かつ集電体自身で平坦部を形成しているので安価に構成できるとともにその平坦部に集電板を接合しているので振動等に対しても安定した構造となり、安定的に充放電できる。

【0032】

また、正極板と負極板をセパレータを介して渦巻き状に巻回し、その両端に両極板の集電体をそれぞれ突出させた極板群を設け、極板群の端部を巻回軸芯方向に押圧して平坦部を形成すると、集電板を接合するための集電体の平坦部を押圧によって能率良く形成することができる。

【0033】

また、平坦部に集電板を当接配置し、周方向複数箇所を放射方向にレーザ溶接すると、集電体の側端縁の多数箇所を集電板に簡単に一体溶着することができ、高い集電効率を作業性良く達成することができる。

【0034】

また、集電板に、集電体の平坦部に向けて突出する突条部を突設し、突条部を押圧させることにより集電体の平坦部を形成すると共に、突条部で集電体と集電板を溶接すると、集電板と平坦部が突条部で確実に接し、集電板と集電体のより確実な接合状態が得られる。

【図面の簡単な説明】

【図1】

本発明の二次電池の一実施形態の縦断面図である。

【図2】

同実施形態における極板群の集電体の突出部に平坦部を形成する工程の縦断面図である。

【図 3】

同実施形態における極板群の集電体の平坦部に集電板を接合する工程の斜視図である。

【図 4】

本発明の二次電池の他の実施形態における集電板及びその接合状態を示す斜視図である。

【図 5】

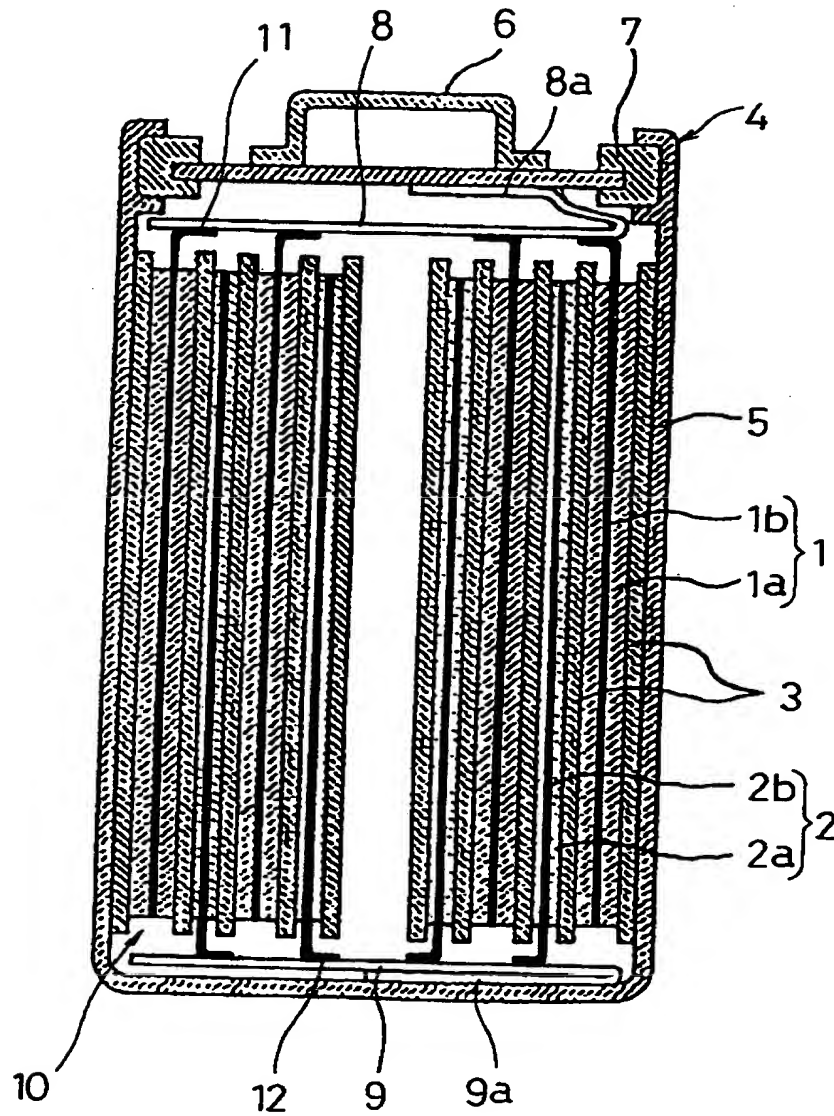
従来例の二次電池の縦断面図である。

【符号の説明】

- 1 正極板
 - 1 a 正極材料
 - 1 b 正極集電体
- 2 負極板
 - 2 a 負極材料
 - 2 b 負極集電体
- 3 セパレータ
- 4 電池容器
- 8 正極集電板
- 9 負極集電板
- 1 0 極板群
 - 1 1 平坦部
 - 1 2 平坦部
 - 1 3 成形治具
 - 1 4 押圧具
 - 1 5 レーザービーム
 - 1 6 突条部

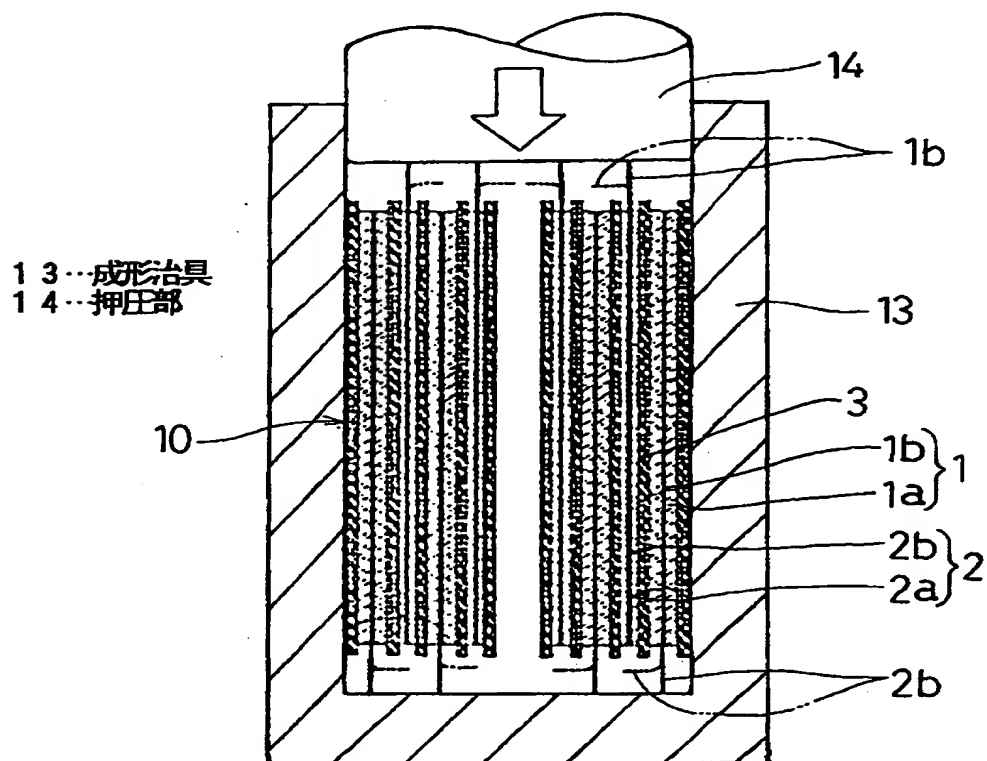
【書類名】 図面

【図 1】



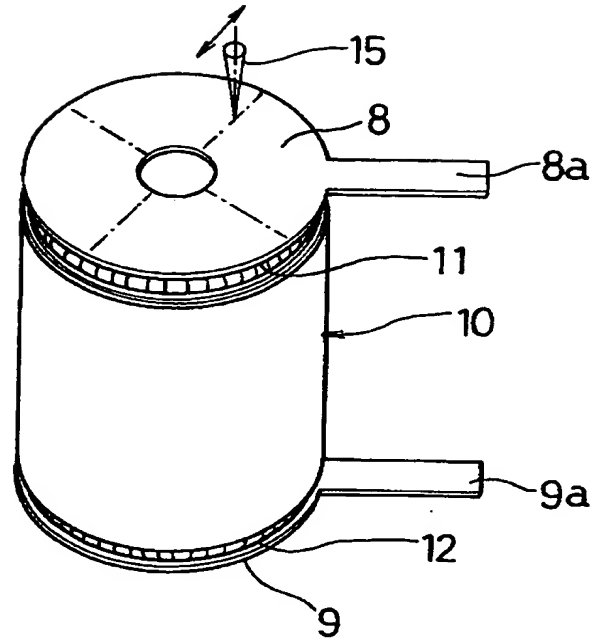
- | | |
|----------|---------|
| 1…正極板 | 3…セパレータ |
| 1a…正極材料 | 4…電池容器 |
| 1b…正極集電体 | 8…正極集電板 |
| 2…負極板 | 9…負極集電板 |
| 2a…負極材料 | 10…極板群 |
| 2b…負極集電体 | 11…平坦部 |
| | 12…平坦部 |

【図 2】

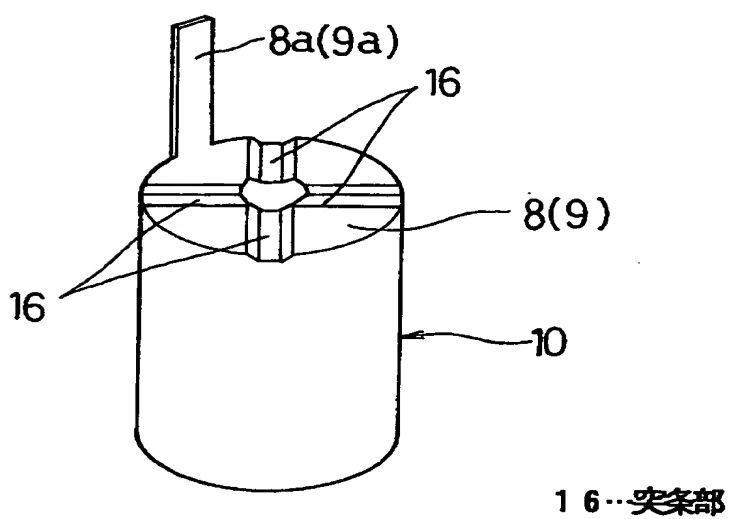


【図 3】

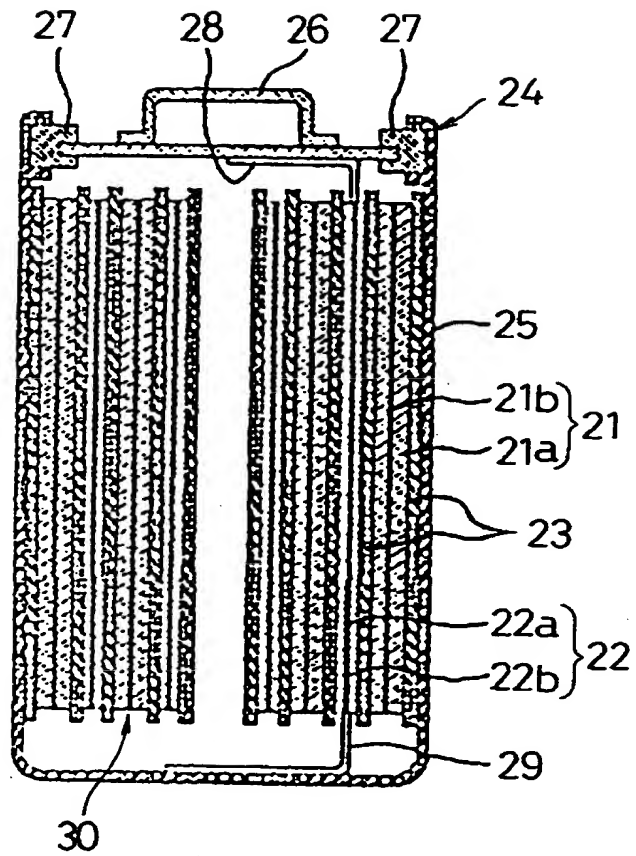
15…レーザビーム



【図 4】



【図 5】



【書類名】 要約書

【要約】

【課題】 集電効率が高く、充放電時の温度上昇を小さくでき、かつ安価な構成で安定的に充放電できる二次電池を提供する。

【解決手段】 正極集電体 1 b に正極材料 1 a を付着させた正極板 1 と負極集電体 2 b に負極材料 2 a を付着させた負極板 2 とをセパレータ 3 を介して積層した極板群 10 を電解液とともに電池容器 4 内に収容した二次電池において、極板群 10 の両端に極板 1、2 の集電体 1 b、2 b をそれぞれ突出させ、その突出部を押圧して集電体 1 b、2 b 自身によって平坦部 11、12 を形成し、この平坦部 11、12 に集電板 8、9 を接合した。

【選択図】 図 1

出 願 人 履 歴 情 報

識別番号 [000005821]

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氏 名 松下電器産業株式会社

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ENGLISH TRANSLATION OF

PRIORITY DOCUMENT

JAPANESE PATENT APPLICATION NO. 11-100750

FILED ON 8 APRIL 1999

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[DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] RECHARGEABLE BATTERY

[SCOPE OF CLAIMS]

[CLAIM 1] A rechargeable battery in which an electrode group obtained by superimposing a positive electrode plate, in which positive electrode material is attached to a positive electrode current collecting element, and a negative electrode plate, in which negative electrode material is attached to a negative electrode current collecting element, with a separator therebetween is accommodated in a battery enclosure together with electrolyte, wherein the current collecting element of one of the electrode plates is made to project on at least one side of the electrode plate group, and current collecting plates are joined to flat sections formed at the tip of this projection by the projection itself.

[CLAIM 2] The rechargeable battery according to claim 1, wherein an electrode plate group is provided in which positive electrode plate and negative electrode plate are wound in spiral fashion with a separator therebetween, with current collecting elements of both electrode plates respectively projecting at both ends thereof, and flat sections are formed by pressing the ends of electrode plate group in the direction of the winding axis core.

Application of [Name] for a patent in the field of [Field]

The following is a description of the invention:

The invention relates to a method of [Description]

which is characterized by the following features:

1. A method of [Description]

2. A method of [Description]

3. A method of [Description]

4. A method of [Description]

5. A method of [Description]

6. A method of [Description]

7. A method of [Description]

8. A method of [Description]

9. A method of [Description]

10. A method of [Description]

11. A method of [Description]

12. A method of [Description]

13. A method of [Description]

14. A method of [Description]

15. A method of [Description]

16. A method of [Description]

17. A method of [Description]

18. A method of [Description]

19. A method of [Description]

20. A method of [Description]

[CLAIM 3] The rechargeable battery according to claim 2, wherein current collecting plates are arranged in contact with flat sections, and are laser-welded in the radial direction at a plurality of locations in the circumferential direction.

[CLAIM 4] The rechargeable battery according to claim 2 or 3, wherein ribs are provided that project toward the projections of the current collecting elements on the current collecting plates, and the flat sections of the current collecting elements are formed by pressing ribs thereupon and welding the current collecting elements and the current collecting plates at ribs.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[TECHNICAL FIELD OF THE INVENTION]

The present invention relates to rechargeable batteries, and in particular to rechargeable batteries wherein an electrode plate group obtained by superimposing a positive electrode plate, in which positive electrode material is attached to a positive electrode current collecting element, onto a negative electrode plate, in which negative electrode material is attached to a negative electrode current collecting element, with a separator therebetween, is accommodated in a battery enclosure together with electrolyte.

[0002]

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[PRIOR ART]

In recent years, there has been rapid progress in reducing the size and weight of electronic equipment, which has increased demands to reduce the size and weight and increase the capacity of the batteries used as their power sources.

[0003]

To meet these demands, lithium ion rechargeable batteries employing a carbon-based material as the negative electrode active substance and employing a transition metal oxide containing lithium, such as LiCoO_2 , as the positive electrode active substance have been put into practice by various companies. Lithium rechargeable batteries in which metallic lithium or lithium alloy is employed as the negative electrode active substance are subject to the problem that precipitation of the lithium onto the negative electrode occurs due to charging, but lithium ion rechargeable batteries do not suffer from this problem and so have excellent cycle characteristics. As a result, there has been vigorous development of lithium ion rechargeable batteries and their use in electronic equipment has become more common.

[0004]

There has also been vigorous development of lithium rechargeable batteries as a means of solving global environmental problems or energy problems. As a way of

Abstract: This document describes a method for determining the relative positions of two objects in a three-dimensional space. The method involves measuring the time delay between the emission and reception of a signal from each object. The time delay is proportional to the distance between the object and the receiver. By comparing the time delays for two objects, their relative positions can be determined. This method is particularly useful for applications where precise location information is required, such as in navigation systems or in the study of celestial bodies.

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1. The method of the present invention is for determining the relative positions of two objects in a three-dimensional space. The method involves measuring the time delay between the emission and reception of a signal from each object. The time delay is proportional to the distance between the object and the receiver. By comparing the time delays for two objects, their relative positions can be determined.

2. The method of the present invention is particularly useful for applications where precise location information is required, such as in navigation systems or in the study of celestial bodies.

guaranteeing power stability while maintaining a good global environment, implementation of technology for load equalization is desired; considerable benefits in terms of load equalization could be expected if use of small-scale battery power storage devices capable of storing power during the night could be made common in ordinary households etc. In order to prevent atmospheric pollution by car exhaust gases and global warming due to CO₂, it would also be desirable to extend the use of electric cars in which some or all of the motive power is obtained by rechargeable batteries. Large lithium ion rechargeable batteries with a cell capacity of about 100 Ah are therefore being developed for use as battery power storage devices for domestic use and as power sources for electric cars.

[0005]

The construction of such a lithium ion rechargeable battery is shown in Figure 5. An electrode plate group 30 constituted by superimposing a positive electrode plate 21, in which positive electrode material 21a is attached to a positive electrode current collecting element 21b, and a negative electrode plate 22, in which negative electrode material 22a is attached to a negative electrode current collecting element 22b, wound in spiral fashion with a separator 23 therebetween are accommodated in a battery enclosure 24 comprising battery case 25 and battery cover 26

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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TABLE 1. *Mean values of the variables measured in the 1989 and 1990 surveys*

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1. The first of these is the fact that the majority of the population of the United States is now living in urban areas. This is a result of the process of urbanization, which has been going on since the beginning of the 20th century. The population of the United States has increased from about 100 million in 1900 to over 200 million in 1950, and the majority of this increase has been in urban areas. This has led to a concentration of population in a few large cities, which has in turn led to a number of problems, such as overcrowding, pollution, and traffic congestion.

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the 1990s, the number of people in the world who are under 15 years of age is expected to increase by 1.5 billion (United Nations, 1994). The United Nations also predicts that the number of people aged 65 and over will increase by 1 billion in the next 20 years (United Nations, 1994). The rapid increase in the number of people in the world who are under 15 years of age and the rapid increase in the number of people aged 65 and over are two of the most significant demographic changes in the world in the 1990s. These changes are expected to have a major impact on the world's economy and society. The rapid increase in the number of people in the world who are under 15 years of age is expected to lead to a rapid increase in the world's population. The rapid increase in the number of people aged 65 and over is expected to lead to a rapid increase in the world's aging population. These changes are expected to have a major impact on the world's economy and society. The rapid increase in the number of people in the world who are under 15 years of age is expected to lead to a rapid increase in the world's population. The rapid increase in the number of people aged 65 and over is expected to lead to a rapid increase in the world's aging population. These changes are expected to have a major impact on the world's economy and society.

1. *Chlorophyll a* (Chl *a*)

100

Figure 1. The effect of the concentration of the *Agrobacterium* suspension on the transformation efficiency of *Agrobacterium* strains. The *Agrobacterium* strains were grown in the YEA medium for 24 h at 28 °C. The cell concentration of the strains was adjusted to 10⁸ cells/ml. The cell suspension was then mixed with the plant tissue and the transformation efficiency was determined. The results were expressed as the mean ± SD of three independent experiments.

together with electrolyte; a positive electrode current collecting element tab 28 with one end joined to a suitable location of a positive electrode current collecting element 21b has its other end connected to the inner surface of battery cover 26 constituting the positive electrode terminal, while the negative electrode current collecting element tab 29 with one end joined to a suitable location of negative electrode current collecting element 22b has its other end connected to the inside bottom surface of battery case 25 constituting the negative electrode terminal. Insulating packing 27 is introduced in between the inner circumference of the top end aperture of battery case 25 and the outer circumference of battery cover 26 so as to mutually insulate battery case 25 and battery cover 26 and to seal battery enclosure 24.

[0006]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

However, since, in a rechargeable battery constructed as described above, current was extracted from a single location of a positive electrode plate 21 and negative electrode plate 22 through current collecting tabs 28 and 29, the average distance from positive electrode plate 21 and negative electrode plate 22 to current collecting tabs 28 and 29 was long, and the area of current collecting tabs 28 and 29 was small, so their electrical resistance was large and the

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the 1990s, the number of people in the world who are under 15 years of age is expected to increase from 1.1 billion to 1.5 billion. The number of people aged 65 and over is expected to increase from 200 million to 400 million. The number of people aged 15 and over is expected to increase from 3.5 billion to 4.5 billion. The number of people aged 15 and over is expected to increase from 3.5 billion to 4.5 billion. The number of people aged 15 and over is expected to increase from 3.5 billion to 4.5 billion.

1. *Journal of the American Medical Association*, 1997; 277: 1033-1036.

Journal of Management Education 36(7) 809–824

the 1990s, the number of people in the world who are illiterate has increased from 1.2 billion to 1.5 billion. The number of illiterate people in the world is projected to reach 1.7 billion by the year 2015. The number of illiterate people in the world is projected to reach 1.7 billion by the year 2015.

1. *Journal of the American Medical Association*, 1997; 277: 1039-1043.

the 1990s, the number of people in the world who are under 15 years of age is expected to increase from 1.1 billion to 1.5 billion, and the number of people aged 65 and over is expected to increase from 0.2 billion to 0.5 billion (United Nations, 1994).

the 1990s, the number of people in the world who are illiterate has increased from 1.2 billion to 1.5 billion. The number of illiterate people in the world is expected to increase to 1.7 billion by the year 2015. The number of illiterate people in the world is expected to increase to 1.9 billion by the year 2020. The number of illiterate people in the world is expected to increase to 2.1 billion by the year 2025. The number of illiterate people in the world is expected to increase to 2.3 billion by the year 2030. The number of illiterate people in the world is expected to increase to 2.5 billion by the year 2035. The number of illiterate people in the world is expected to increase to 2.7 billion by the year 2040. The number of illiterate people in the world is expected to increase to 2.9 billion by the year 2045. The number of illiterate people in the world is expected to increase to 3.1 billion by the year 2050. The number of illiterate people in the world is expected to increase to 3.3 billion by the year 2055. The number of illiterate people in the world is expected to increase to 3.5 billion by the year 2060. The number of illiterate people in the world is expected to increase to 3.7 billion by the year 2065. The number of illiterate people in the world is expected to increase to 3.9 billion by the year 2070. The number of illiterate people in the world is expected to increase to 4.1 billion by the year 2075. The number of illiterate people in the world is expected to increase to 4.3 billion by the year 2080. The number of illiterate people in the world is expected to increase to 4.5 billion by the year 2085. The number of illiterate people in the world is expected to increase to 4.7 billion by the year 2090. The number of illiterate people in the world is expected to increase to 4.9 billion by the year 2095. The number of illiterate people in the world is expected to increase to 5.1 billion by the year 2100.

current collecting efficiency was poor. Furthermore, since the current collecting efficiency was poor, there was the problem that charging and discharging with large currents resulted in increased battery temperatures, which shortens the life of the rechargeable battery.

[0007]

As a means of solving this problem, for example Laid-open Japanese Patent publication number H. 8-115744 discloses a constitution of an electrode group comprising a positive electrode end face and negative electrode end face formed at the edge of a current collecting element and leads at both ends, by winding both electrode plates, with a separator therebetween, in a condition in which their respective leads are arranged at the tips of projections thereof, with the current collecting elements of the two electrode plates projecting at side parts on respectively opposite sides, the terminals being connected to this positive electrode end face and negative electrode end face respectively. However, this is subject to the problem of high cost, since leads are required and the manufacturing steps become complicated.

[0008]

Also, Laid-open Japanese patent application number H. 10-21953 discloses an arrangement in which current collecting elements of both electrode plates project at side parts on

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... ..

... e, portanto, a implementação de um modelo de ensino

[illegible]

THIS PAGE: A 1940s-era photograph of a group of people, possibly a family, standing outdoors. The image is partially obscured by a large, bold, black stamp that reads "THIS PAGE" diagonally across the top right corner. The photograph shows several individuals, including what appears to be a woman in the center, surrounded by others, in a natural setting. The overall tone is historical and somewhat somber.

UNITED STATES DEPARTMENT OF COMMERCE
BUREAU OF ECONOMIC ANALYSIS
WASHINGTON, D. C. 20540

15000

1. *Journal of the American Medical Association*, 1997; 277: 1039-1043.

1. The first step is to identify the problem. In this case, the problem is that the company is not meeting its sales targets. The second step is to analyze the data. The third step is to develop a plan. The fourth step is to implement the plan. The fifth step is to evaluate the results.

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respectively opposite sides and their tips make resilient pressure contact with the positive electrode terminal and negative electrode terminal. However, since connection is only effected with the terminals by bending of the tip of the current collecting element in an acute-angled shape within the elastic range, by the elastic restoring force thereof, the electrical connection is unstable and the problem is experienced of a lack of stability of the battery's output under conditions of use in which it is subjected to vibration.

[0009]

In view of the above problems of the prior art, an object of the present invention is to provide a rechargeable battery wherein the efficiency of current collection is high, the rise in temperature during charging/discharging can be reduced, and in which charging/discharging can be achieved in a stable fashion with an inexpensive construction.

[0010]

[MEANS FOR SOLVING THE PROBLEMS]

In a rechargeable battery according to the present invention, in which an electrode group obtained by superimposing a positive electrode plate, in which positive electrode material is attached to a positive electrode current collecting element, and a negative electrode plate, in which negative electrode material is attached to a negative electrode current collecting element, with a

separator therebetween is accommodated in a battery enclosure together with electrolyte, the current collecting element of one of the electrode plates is made to project on at least one side of the electrode plate group, and current collecting plates are joined to flat sections formed at the tip of these projections by the projections themselves. Since the current collecting plates are joined to flat sections formed on one side of the current collecting elements, the current collection efficiency is high and the rise in temperature during charging/discharging can be kept small. Furthermore, since the flat sections are formed by the current collecting elements themselves, the construction can be made inexpensive and the construction is stable with respect to vibration etc since these current collecting plates are joined to these flat sections, so charging and discharging can be effected in a stable fashion.

[0011]

If an electrode plate group is provided in which the positive electrode plate and negative electrode plate are wound in spiral fashion with a separator therebetween, with current collecting elements of both electrode plates respectively projecting at both ends thereof, and flat sections are formed by pressing the ends of the electrode plate group in the direction of the winding axis core, formation can be effected in a efficient fashion by pressing

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the flat sections of the current collecting elements for joining the current collecting plates.

[0012]

If the current collecting plates are arranged so as to make contact with the flat sections, and are laser-welded in the radial direction at a plurality of locations in the circumferential direction, a large number of locations of the side edges of the current collecting elements can be integrally welded in a simple fashion to the current collecting plates, making it possible to achieve high current collection efficiency with an easy operation.

[0013]

If ribs are provided that project towards the projections of the current collecting elements on the current collecting plates and the flat sections of the current collecting elements are formed by pressing ribs thereupon and welding the current collecting elements and the current collecting plates at the ribs, reliable contact between the current collecting plates and flat sections can be achieved at the ribs, and a more reliable joined condition of the current collecting plates and current collecting elements can be obtained.

[0014]

[EMBODIMENTS OF THE INVENTION]

A lithium ion rechargeable battery according to an embodiment of the rechargeable battery of the present invention is described below with reference to Figure 1 to Figure 3.

[0015]

In Figure 1, 1 is a positive electrode plate and 2 is a negative electrode plate; an electrode plate group 10 is constituted by winding in spiral fashion positive electrode plate 1 and negative electrode plate 2 in a mutually opposed condition with a separator 3 made of microporous polyethylene film therebetween; this electrode plate group 10 is accommodated and arranged within battery enclosure 4 together with electrolyte. Battery enclosure 4 comprises a battery case 5 which is of cylindrical enclosure shape and constitutes a negative electrode terminal and a battery cover 6 constituting a positive electrode terminal; battery enclosure 4 is sealed and mutual insulation is effected by means of insulating packing 7 interposed between the inner circumference of the top aperture of battery case 5 and the outer circumference of battery cover 6. Separator 3 is interposed between electrode plate group 10 and the inner circumference of battery case 5.

[0016]

Positive electrode plate 1 is constituted by coating both surfaces of positive electrode current collecting

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element 1b with positive electrode material 1a; a side part (in the example illustrated, the top part) of this positive electrode current collecting element 1b projects from the portion that is coated with positive electrode material 1a. Also, negative electrode plate 2 is constituted by coating both surfaces of negative electrode current collecting element 2b with negative electrode material 2a; the other side part (in the example illustrated, the bottom part) of this negative electrode current collecting element 2b projects from the portion that is coated with negative electrode material 2a. Separator 3 projects to the outside beyond both side edges of the coated portions of positive electrode plate 1 and negative electrode plate 2.

[0017]

A flat section 11 is formed by plastic deformation of the projection of positive electrode current collecting element 1b by pressing the portion of positive electrode current collecting element 1b that projects beyond separator 3, and positive electrode current collecting plate 8 is joined to this flat section 11. Likewise, a flat section 12 is formed by plastic deformation of the projection of negative electrode current collecting element 2b by pressing the portion of negative electrode current collecting element 2b that projects beyond separator 3, and negative electrode current collecting plate 9 is joined to this flat section 12.

This positive electrode current collecting plate 8 and negative electrode current collecting plate 9 are respectively connected to battery cover 6 and battery case 5. 8a and 9a are connecting strips extending from the outer circumference for connecting the current collecting plates 8 and 9 to the inside surface of battery cover 6 and the inside bottom surface of battery case 5.

[0018]

A detailed description of positive electrode plate 1, negative electrode plate 2 and the electrolyte will now be given. Positive electrode current collecting element 1b is made of aluminum foil or the like and positive electrode plate 1 is constituted by coating both surfaces thereof with positive electrode material 1a containing positive electrode active substance and a binding agent. The positive electrode active substance employed is LiCoO_2 , LiMn_2O_4 , LiNiO_2 , a product in which some of this Co, Mn or Ni is substituted with another transition metal, or a lithium-containing transition metal oxide other than these. In particular, Mn-based lithium-containing transition metal oxides such as the globally abundant low-cost LiMn_2O_4 are suitable.

[0019]

Negative electrode current collecting element 2b is made of copper foil or the like and negative electrode plate 2 is constituted by coating both surfaces thereof with negative

electrode material 2a containing negative electrode active substance and a binding agent. The negative electrode active substances employed may be carbon-based materials such as graphite, petroleum coke, carbon fiber, or organic polymer sintered products, or there may be employed metals or oxides capable of occluding and releasing lithium, or composite materials of these.

[0020]

Also, as the electrolyte, it is possible to employ electrolytes obtained by dissolving as solute a lithium salt such as lithium hexafluorophosphate (LiPF_6), lithium perchlorate (LiClO_4), or lithium fluoroborate (LiBF_4) using a non-aqueous solvent such as ethylene carbonate (EC), propylene carbonate (PC), diethylene carbonate (DC) or ethylene methyl carbonate (EMC) as solvent, either alone or as a mixed solvent of these, in a concentration of solute of 0.5 mol/dm^3 to 2 mol/dm^3 in the solvent.

[0021]

To give a specific example, positive electrode material 1a was produced by mixing in a respective weight ratio of 92:3:5 LiMn_2O_4 manufactured by mixing electrolyzed manganese dioxide (EMD: MnO_2) and lithium carbonate (Li_2CO_3) with a ratio $\text{Li/Mn} = 1/2$ and sintering in the atmosphere for 20 hours at 800°C , acetylene black serving as conducting agent and polyfluorovinylidene as binding agent. As the

polyfluorovinylidene binding agent used for kneading the positive electrode material 1a into paste form, N-methylpyrrolidone dispersion was employed. The mixing ratios given above are ratios in terms of the solid fractions. The positive electrode material layer was formed by coating both faces of the positive electrode current collecting element 1b made of 20 μm thick aluminum foil with this positive electrode material paste in a condition leaving a region of width 10 mm on one side edge as an uncoated region. The film thickness of both positive electrode material layers was the same and the sum of the two film thicknesses after coating and drying was 280 μm , giving a positive electrode plate thickness of 300 μm . After this, compressive forming was conducted using a press roll of diameter 300 mm to produce a thickness of the positive electrode plate 1 of 200 μm . The density of the positive electrode material was then 3.0 g/cm³.

[0022]

For the negative electrode material 2a, a mixture of artificial graphite and styrene butadiene rubber (SBR) as binding agent in a weight ratio of 97:3 was employed. In order to knead the negative electrode material 2a into the form of a paste, the styrene butadiene rubber binding agent was employed in the form of an aqueous dispersion. The above mixing ratios are expressed as solid fractions. The negative electrode material layer was formed by coating both faces of

the negative electrode current collecting element 2b made of 14 μ m thick copper foil with this negative electrode material paste in a condition leaving a region of width 10 mm on one side edge as an uncoated region. After this, compressive forming was conducted using a press roll of diameter 300 mm to produce a thickness of the negative electrode plate 2 of 170 μ m. The density of the negative electrode material was then 1.4 g/cm³.

[0023]

As the electrolyte, an electrolyte was employed obtained by dissolving lithium hexafluorophosphate (LiPF₆) as solute in a concentration of 1 mol/dm³ in a mixed solution obtained by mixing ethylene carbonate (EC) and diethylene carbonate (DEC) in a volume blending ratio of 1:1.

[0024]

In the manufacturing of such a lithium ion rechargeable battery, an electrode plate group 10 is formed by winding in spiral fashion positive electrode plate 1 and negative electrode plate 2 manufactured as above facing each other with a separator 3 in between and with the uncoated regions of these current collecting elements 1b, 2b projecting at both ends. As shown in Figure 2, this electrode plate group 10 is inserted and arranged in a molding jig 13 of cylindrical enclosure shape, and is subjected to pressure by a pressing implement 14 from one end aperture of molding jig

13. When this is done, flat sections 11, 12 are formed by plastic deformation of the projections of current collecting elements 1b, 2b so that they are bent by about 90° radially inwards as shown by the imaginary lines. Specifically, since positive electrode plate 1 and negative electrode plate 2 are wound in spiral fashion, the projections of current collecting elements 1b, 2b, instead of being bent radially outwards, are subjected to plastic deformation so that they are, overall, bent progressively radially inwards in practically uniform manner so that, although some degree of folding occurs, they are as a whole formed into flat sections 11, 12.

[0025]

Next, the electrode plate group 10 formed with flat sections 11, 12 is removed from molding jig 13 and, as shown in Figure 3, the current collecting plates 8, 9 and flat sections 11, 12 are laser welded by irradiating a plurality of locations in the circumferential direction of the surfaces of the current collecting plates 8, 9 with a laser beam 15 in radial fashion from the middle towards the outer periphery, in a condition with both of these pressed into contact with each other by arranging the current collecting plates 8, 9 so as to press against flat sections 11, 12. After this, the electrode plate group 10 with these current collecting plates 8, 9 joined to it is vacuum impregnated by accommodating it.

within battery case 5 together with the electrolyte and is sealed therein by battery cover 6 and current collecting plates 8, 9, battery cover 6 and battery case 5 are respectively connected by laser welding etc.

[0026]

With a lithium ion rechargeable battery constructed as above, since electrode plate group 10 is provided by winding in spiral fashion a positive electrode plate 1 and negative electrode plate 2 with a separator 3 therebetween with current collecting elements 1b, 2b of the two electrode plates respectively projecting at both ends thereof and the current collecting plates 8, 9 are joined to the flat sections 11, 12 formed on the projections of the current collecting elements 1b, 2b, the efficiency of current collection is high and the rise in temperature during charging/discharging can be kept small. Furthermore, since the flat sections 11, 12 are formed by the current collecting elements 1b, 2b themselves, the construction can be made of low cost and the construction is stable with respect to vibration etc since these flat sections 11, 12 are joined to current collecting plates 8, 9, so charging and discharging can be effected in a stable fashion.

[0027]

Also, since flat sections 11, 12 are formed by applying pressure to both ends of the electrode plate group 10 in the

direction of the core of the winding axis, the flat sections 11, 12 for joining the current collecting plates 8, 9 can be formed in an efficient fashion.

[0028]

Also, since current collecting plates 8, 9 are pressed towards flat sections 11, 12 and subjected to laser welding in the radial direction at a plurality of locations in the circumferential direction in this pressed-together condition, integral welding of a large number of locations of the side edges of current collecting elements 1b, 2b to the current collecting plates 8, 9 can be achieved in a straightforward fashion, enabling high current collection efficiency to be achieved with ease of operation.

[0029]

Although, in the description of the above embodiment, the case was illustrated, by way of example, in which the entire surface of the current collecting plates 8, 9 was of flat plate shape, it would be possible, as shown in Figure 4, for ribs 16 that project towards the projections of current collecting elements 1b, 2b of electrode plate group 10 to be formed projecting in radial fashion on current collecting plates 8, 9, laser welding being effected along ribs 16 in a condition with flat sections 11, 12 formed, current collecting plates 8, 9 being subjected to pressure such that

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16. *Journal of the American Statistical Association*, 1980, 75, 218-221.

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the 1990s, the number of people in the world who are under 15 years of age is expected to increase by 1.5 billion, from 1.1 billion in 1990 to 2.6 billion in 2010. The number of people aged 65 and over is expected to increase by 1 billion, from 350 million in 1990 to 1.4 billion in 2010. The number of people aged 15-64 is expected to increase by 1.5 billion, from 2.5 billion in 1990 to 4.0 billion in 2010. The number of people aged 65 and over is expected to increase by 1 billion, from 350 million in 1990 to 1.4 billion in 2010. The number of people aged 15-64 is expected to increase by 1.5 billion, from 2.5 billion in 1990 to 4.0 billion in 2010.

... ..

Journal of Management Education 30(6)p.789-804

Figure 1. The effect of the concentration of the *Agrobacterium* suspension on the transformation efficiency of *Agrobacterium* strains.

the 1990s, the number of people in the world who are illiterate has increased from 1.2 billion to 1.5 billion. The number of illiterate people in the world is expected to reach 1.7 billion by the year 2015. The number of illiterate people in the world is expected to reach 1.7 billion by the year 2015.

Journal of Management Education 36(7) 809–824

• *Staphylococcus aureus* (Staph aureus) is a Gram positive cocci in clusters. It is a facultative anaerobe and is found in the skin, nose, throat, and in the environment. It is a common cause of skin infections, such as abscesses, boils, and impetigo. It can also cause more serious infections, such as pneumonia, sepsis, and food poisoning.

• • •

these ribs 16 bite into the projections of current collecting elements 1b, 2b.

[0030]

By providing ribs 16 in this way on current collecting plates 8, 9, when laser welding is conducted with these pressed against the projections of current collecting elements 1b, 2b, the flat sections 11, 12 formed on the projections reliably make contact with the current collecting plates 8, 9 through ribs 16, enabling a more reliable joining condition of current collecting plates 8, 9 and current collecting elements 1 b, 2 b to be obtained.

[0031]

[BENEFITS OF THE INVENTION]

As will be clear from the above description, with the rechargeable battery of the present invention, since joining with the current collecting plate is achieved by the current collecting element of one or other of the electrodes projecting on at least one side of the electrode plate group, a flat section being formed at the tip of the projection by the projection itself, current collection efficiency is high and the rise in temperature during charging/discharging can be made small; also, since the flat section is formed by the current collecting element itself, an inexpensive construction can be achieved and since the current collecting plate is joined to the flat section the construction is

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stable with regard to vibration etc. This therefore makes it possible to achieve stable charging/discharging and is useful in realizing high current collection efficiency and stable charging/discharging with an inexpensive construction.

[0032]

If the positive electrode plate and negative electrode plate are wound in spiral fashion with the separator therebetween, with current collecting elements of both electrode plates respectively projecting at both ends thereof, and flat sections are formed by pressing the ends of the electrode plate group in the direction of the winding axis core, formation can be effected in a efficient fashion by pressing the flat sections of the current collecting elements for joining the current collecting plates.

[0033]

If the current collecting plates are arranged so as to make contact with the flat sections, and are laser-welded in the radial direction at a plurality of locations in the circumferential direction, a large number of locations of the side edges of the current collecting elements can be integrally welded in a simple fashion to the current collecting plates, making it possible to achieve high current collection efficiency with an easy operation.

[0034]

If ribs are provided that project towards the projections of the current collecting elements on the current collecting plates and the flat sections of the current collecting elements are formed by pressing ribs thereupon and welding the current collecting elements and the current collecting plates at the ribs, reliable contact between the current collecting plates and flat sections can be achieved at the ribs, and a more reliable joined condition of the current collecting plates and current collecting elements can be obtained.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Figure 1 is an axial cross-sectional view of an embodiment of a rechargeable battery according to the present invention;

Figure 2 is an axial cross-sectional view of a step wherein a flat section is formed on a projection of a current collecting element of an electrode plate group in this embodiment;

Figure 3 is a perspective view of a step in which the current collecting plate is joined to the flat section of the current collecting element of the electrode plate group in this embodiment;

Figure 4 is a perspective view illustrating the current collecting plate and the joined condition thereof in a

Figure 1

Figure 1 is a schematic diagram of the apparatus for the measurement of the rate of reaction between a gas and a solid.

The apparatus consists of a gas cylinder, a gas flowmeter, a reaction chamber, and a gas analyzer.

The gas cylinder is connected to the gas flowmeter, which is in turn connected to the reaction chamber.

The reaction chamber is connected to the gas analyzer, which is in turn connected to a gas outlet.

The gas flowmeter is used to measure the rate of flow of gas through the reaction chamber.

The gas analyzer is used to measure the concentration of gas in the gas outlet.

The rate of reaction is determined by measuring the rate of change of the concentration of gas in the gas outlet.

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further embodiment of a rechargeable battery according to the present invention; and

Figure 5 is an axial cross-sectional view of a rechargeable battery according to an example of the prior art.

[DESCRIPTION OF THE REFERENCE NUMERALS]

- 1 positive electrode plate
- 1a positive electrode material
- 1b positive electrode current collector
- 2 negative electrode plate
- 2a negative electrode material
- 2b negative electrode current collector
- 3 separator
- 4 battery container
- 8 positive electrode current collector plate
- 9 negative electrode current collector plate
- 10 electrode plate group
- 11 flat plane
- 12 flat plane
- 13 molding jig
- 14 press member
- 15 laser beam
- 16 rib

[DOCUMENT] ABSTRACT

[ABSTRACT]

[OBJECT] To provide a rechargeable battery of an inexpensive structure, which exhibits high current collecting efficiency and stable charging/discharging characteristics, and with which the rise in temperature during charging/discharging can be made small.

[MEANS FOR SOLUTION]

 In a rechargeable battery in which an electrode group 10 obtained by superimposing a positive electrode plate 1, in which positive electrode material 1a is attached to a positive electrode current collecting element 1b, and a negative electrode plate 2, in which negative electrode material 2a is attached to a negative electrode current collecting element 2b, with a separator 3 therebetween is accommodated in a battery enclosure 4 together with electrolyte, the current collecting elements 1b, 2b of the electrode plates 1, 2 are respectively made to project at both ends of the electrode plate group 10, and current collecting plates 8, 9 are joined to flat sections 11, 12 formed by current collecting elements 1b, 2b themselves by pressing these projections.

[SELECTED DRAWING] Figure 2

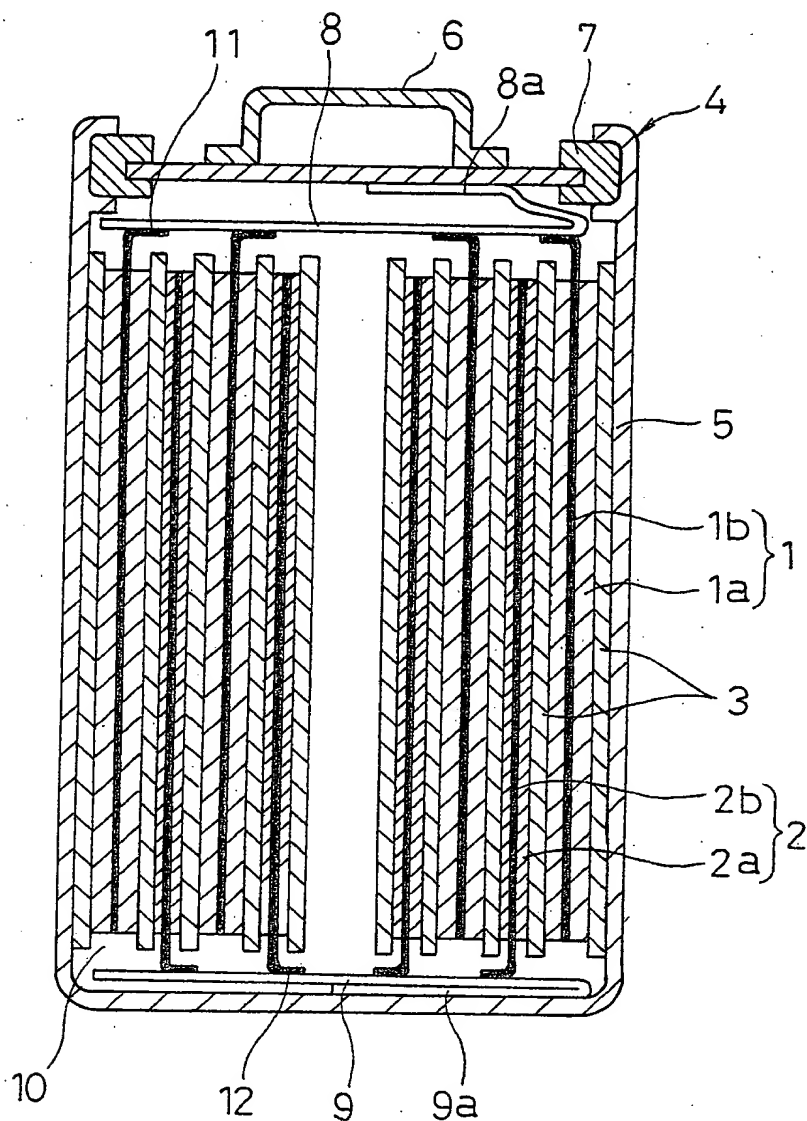
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[Document] Drawing
[Fig. 1]



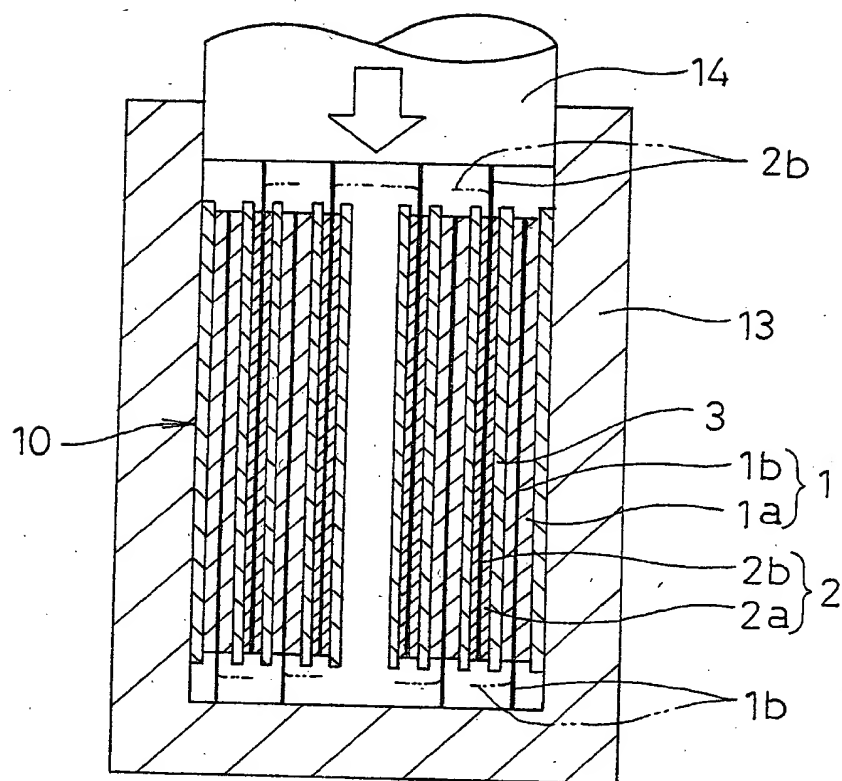
- 1 positive electrode plate
- 1a positive electrode material
- 1b positive electrode current collector
- 2 negative electrode plate
- 2a negative electrode material
- 2b negative electrode current collector
- 3 separator
- 4 battery container
- 8 positive electrode current collector plate
- 9 negative electrode current collector plate
- 10 electrode plate group
- 11 flat plane
- 12 flat plane

FIG. 1. A perspective view of the invention showing a container 10 with a lid 12 and a base 14. The container 10 is shown in a partially open position, revealing a plurality of compartments 16 and 18. The lid 12 is hinged to the base 14 at 20. The compartments 16 and 18 are arranged in a grid pattern. The base 14 is shown with a series of lines indicating its internal structure.



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[Fig. 2]

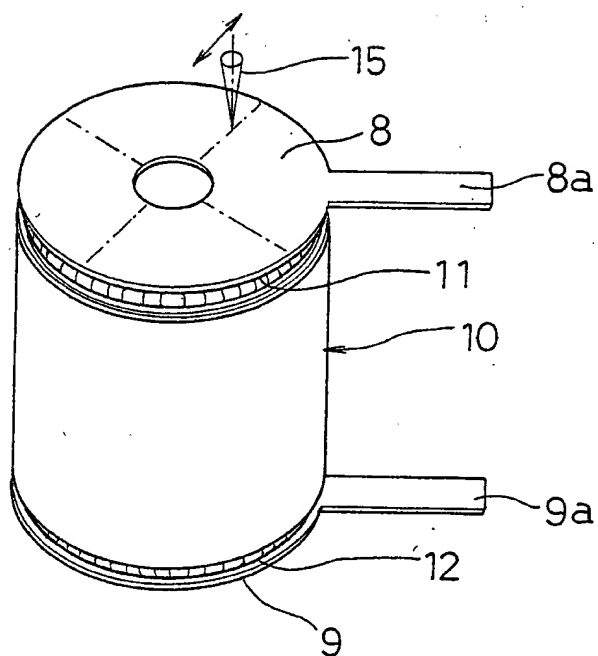


13 molding jig
14 press member

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[Fig. 3]

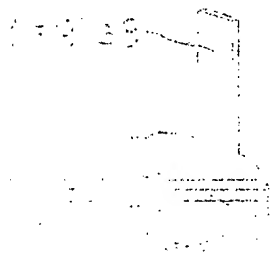


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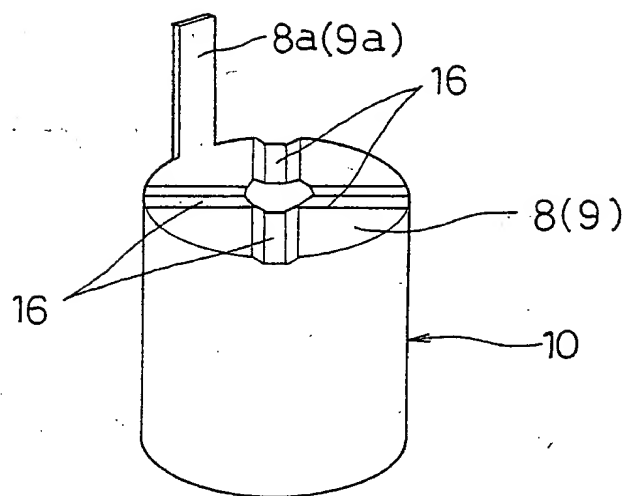
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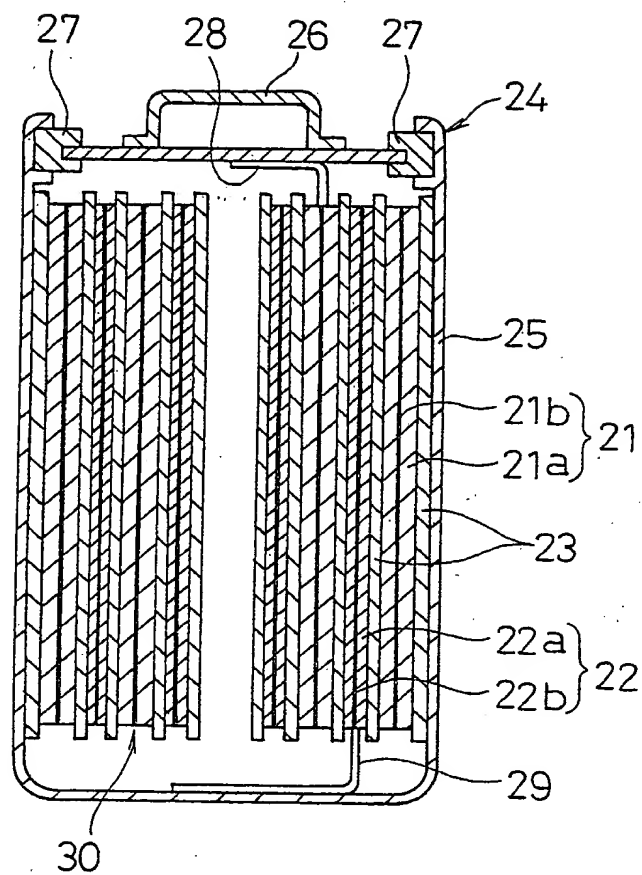


[Fig. 4]



16 rib

[Fig. 5]



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